be in some way dependent on the fact that any variety of sulphur increases in conductivity with rise of temperature. Unless it is suggested that we did not know one temperature from another, I fail to understand this criticism. RICHARD THRELFALL.

University, Sydney, N.S.W.

I SEE no reason to recall what I have said regarding the general attitude of chemists and physicists on the question of the influence of minute traces of impurity; and when I come across the remark in Messrs. Threlfall, Brearley and Allen's paper in the *Phil. Trans.*, that "it is not too much to say that the electrical action of most bodies in a pure state is entirely unknown at present," I feel there is not much difference of opinion between us.

Then, as to my being guilty of that unpardonable crime—pedantry—it has always seemed to me that those of us who undertake scientific work should also strive to be scientific, *i.e.* exact, in their use of language. Those who had the great good fortune to be present a year or so ago at the NATURE dinner, and to hear Huxley's marvellous speech—almost, if not the last he delivered—will recollect how strongly he insisted on the importance of greater care being taken in the writing of papers describing scientific inquiries. In a conversation I had with him afterwards, he greatly lamented the careless manner in which such work was too frequently done.

Now if *pure* mean "free from mixture," a pure substance must, as I have said, ever remain an ideal conception; the purist must ever regard all things as impure. Prof. Threlfall tells us that "the word pure has no significance except with respect to a definite state of the art of chemistry." I would rather accept the meaning which is to be found in the dictionary, *pace* Stas even; and would prefer to assert that the word too frequently has no significance except with reference to an indefinite state of the mind of the person—chemist or physicist—using it. To my mind, there can only be degrees of impurity—not of purity.

Whatever time Prof. Threlfall and his colleagues may have spent in seeking to purify sulphur, the fact remains that their experiments were made with sulphur which they obtained by chance, and that the only method of purifying it they adopted was to distil it several times in vacuo, after filtering it while molten through glass wool and platinum gauze, and then to fuse it in vacuo—in order, they tell us, to get rid of gases (probably water vapour, they say) given off even from the purest samples. But distillation in vacuo, even when followed by fusion in vacuo, can scarcely be regarded as a process which "exhausts the resources of physics, including chemistry."

"Chance" sulphur is prepared by burning sulphuretted hydrogen. It is probably impossible to burn sulphur without producing some sulphuric acid. Messrs. Threlfall, Brearley and Allen, however, do not even refer to the possibility of its presence, and apparently took no precaution whatever to eliminate it, if present.

They tell us that on breaking up such sulphur after it had been strained while molten through glass wool and platinum gauze, it emitted a horrible smell of gas-lime, "which shows that it requires to be distilled if sure results are to be obtained." I imagine, therefore, that the sulphur they used initially was by no means so remarkably "pure"; as they also state that gases were given off even from the purest samples when fused in vacuo after distillation, it may well be doubted whether so simple a process as mere fusion could suffice to effect the necessary final purification.

Prof. Threlfall's statement that conducting "mixtures" were caused to become non-conducting by annealing, is apparently a good answer to my criticism; but by no means finally disposes of it. The structure of the two materials may have been very different, and such in the one case as to allow an impurity to act, which in the other case might be inoperative. By my reference to the conductivity of sulphur at temperatures above its melting point, I meant to imply that the behaviour described afforded indication of the presence of impurity; for I do not believe that even molten sulphur is a conductor. Of course, at present, this is but an opinion, but it may not be inappropriate to direct attention to the recent most remarkable observations of Dewar and Fleming on bismuth, showing that an amount of impurity altogether beyond detection by chemical means may entirely alter electrical properties.

I still, therefore, regretfully retain my opinion, and fear that, notwithstanding the great care lavished on the work of Prof. Threlfall and his colleagues, it will be necessary to repeat it, perhaps over and over again—a possibility which they apparently themselves foresee in the introduction to their paper—before so remarkable a conclusion as that they have arrived at can be regarded as established.

H. E. ARMSTRONG.

Increasing the Efficiency of Röntgen Ray Tubes.

MR. J. C. PORTER, in a letter in NATURE of June 18, describes a method of increasing the efficiency of a Crookes' tube. I have for some weeks used another very simple method to obtain the same result. This consists in placing the flame of a small glass spirit-lamp in the angle formed by the Crookes' tube and the wire passing to the kathode, and allowing a series of small sparks to pass to the flame from the wire.

Burnley, June 29. T. G. CRUMP.

THE POSITION OF SCIENCE AT OXFORD.

WHILST the study of natural science has been progressing rapidly in other universities and colleges during the last ten or fifteen years, it is a matter of common knowledge that it has progressed very slowly indeed in the University of Oxford. It would be incorrect to say that it has not progressed, for there has been during the last few years a steady, though very gradual, increase in the numbers of men reading for honours in the final school of natural science. In 1885 twenty-two men obtained honours in sciencce, in 1895 there were forty-three names in the class list, and a rather larger number in 1894. The school has just doubled itself in ten years, but for all that the numbers are still small, and out of all proportion to the provision that has long existed for science teaching in the University. It must be understood at the outset that the University, considered as a body separate from the colleges which compose it, has not dealt ungenerously with science. The staff of professors, and the emoluments attached to their chairs, compare favourably with those of any other university in Great Britain; and Oxford actually set the example, at great cost to itself, of building a museum and equipping laboratories for educational purposes. Moreover, the opportunities of scientific study in Oxford are greatly enhanced by the existence within the precincts of the museum of a first-rate scientific library, such as is not possessed by any other college or university in the kingdom. It is a strange thing that when it has so many advantages, Oxford has allowed itself to be completely outstripped in this particular path of intellectual progress.

It is the purpose of the present article to discuss the possible causes of comparative failure of the science school at Oxford. A complete failure it is not, for, however poor its numerical results may be, it has long been recognised that the attainments of the limited number of scientific men which it turns out compare well with those of men who have been educated in other places.

It is commonly supposed that the prime cause of the insignificant numerical result is the small encouragement given to scientific study in the shape of fellowships and scholarships; and those who hold this opinion believe that if the colleges were to do what is conceived to be their duty in this respect, the science school would progress by leaps and bounds.

With respect to scholarships and exhibitions, it is apparent, from an analysis of the figures, that science does not get what may rightly be held to be its due. The *University Calendar* for 1896 shows that there are in Oxford some 500 scholarships of an annual value of £80 a-piece, and in addition some 225 exhibitions, the annual value of each of which may be placed at £40, These figures apply only to college scholarships and exhibitions, and so it appears that the colleges, apart from the University, exercise an intellectual patronage to the extent of nearly £50,000 per annum. How is this patronage exercised, and what share of it falls to natural science?

It is not unreasonable to say that bare justice would be done if the number of scholarships allotted to science bore the same proportion to the number of men reading for honours in that subject as the number of scholarships allotted to literary subjects bears to the number of men reading for the literary schools. This bare measure of justice is not done. In 1895 one hundred and fifty-three men were classed in the honour school of Literæ Humaniores (a number beyond all previous precedent); eighty-seven were classed in Modern History; sixty-six in the honour school of Jurisprudence; forty-three in Natural Science; thirty-seven in Theology; twenty-three in Mathematics; and one in "Literis Semiticis"; in all four hundred and ten. Deduct twenty from this number to exclude those who took a second final school, and there remain three hundred and ninety, of whom forty-three, or one ninth of the whole, belonged to the school of Natural Science. Science, on this reckoning, should claim fifty-five out of the five hundred existing scholarships. It is not very easy to ascertain the exact number of science scholarships, but there are certainly not more than forty. It appears from the *University Gazette* that in the academical year 1894-95 only ten out of twenty-one colleges offered scholarships or exhibitions in Natural Science, and that those ten have offered science scholarships for some years past. The ten are Balliol, Merton, New College, Magdalen, Christ Church, Trinity, Corpus Christi, Jesus, Keble, and Queen's. The scholarship at the last named, though in fact awarded to a candidate who offered Natural Science, was equally open to candidates offering Classics or Mathematics. In addition, St. John's offered and awarded a scholarship in mathematics and physics, either separately or in combination. As each of the ten colleges gave one science scholarship, and as the tenure of a scholarship is four years, it follows that there are only forty science scholarships in the University, or if St. John's be added, forty four—at the lowest computation ten less than there should be.

The paucity of science scholarships has been a frequent subject of comment; but the colleges have a ready and a very plausible answer, which is best illustrated by the fact that in November last Balliol did not award a science scholarship because no candidate of sufficient merit presented himself. It is a fact that the candidates for science scholarships are not only few in number, but also of low average merit; there are, of course, brilliant exceptions. It is not easy to fix a common measure for the intellectual acquirements of classical and scientific students, but as far as a comparison can be instituted, it is vastly to the advantage of the classical scholar. He is a better classic than his scientific confrère is a man of science, and is in addition more widely read and has a greater knowledge of subjects of general interest. The most that can be said is that the science scholar knows a little of classics, a classical scholar as a rule is profoundly ignorant of science. But in powers of expression, in the ability to handle an unfamiliar theme, and in range and variety of knowledge, there is simply no comparison. Hence the colleges justify themselves by saying that they award scholarships to candidates of the greatest intellectual merit, and it is their experience that the greatest merit is found in those who have had a classical education. As for science scholarships, the competitors, they say, are not worthy of the prize, and the prize is accordingly withdrawn, with the result that the number of science scholarships tends to diminish rather than to increase.

This is true, and it is a lamentable state of things, pointing to a serious deficiency in the secondary education which precedes and leads up to a University education. It is, however, remarkable that Cambridge, which gives plenty of science scholarships, finds no difficulty in getting candidates of sufficient merit. The explanation of this is probably somewhat as follows. At Oxford scholarships are nearly exclusively awarded to boys who are still at school; very few are open to undergraduates who have been in residence for more than one University Term. At Cambridge many scholarships are open to men of one year's standing, giving an opportunity to those who have come up to the University with a fair general education and only a moderate acquaintance with science, to learn enough science in their first year to bring themselves up to the standard of a scholarship; many at Oxford would be glad of such a chance, but it is not open to them. In the second place, the science school at Cambridge has acquired such a prestige that the best boys go there, and only the second best to Oxford; and thirdly, Oxford draws its undergraduates more exclusively from the great public schools than Cambridge does. Taken on the whole the teaching of science in public schools is bad. There are, of course, some exceptions, but they are rare, and in many science can hardly be said to be taught at all. It may be objected that every public school has one or more science masters of tried capacity, and that science is a compulsory subject in nearly all. It may be so, but the inducements offered to the study of science in public schools are very few; in most of them there are not only no inducements, but the study is openly discouraged. Boys are not generally inclined to give themselves unnecessary trouble over their studies, and are only too ready to neglect that which may safely be neglected; the science masters have no chance with the majority of them, and have to resign themselves to giving as much trouble and time as school regulations permit to the few enthusiasts who care to add science to their classical burdens. For all the pretence that public schools make of teaching science, the average schoolboy comes up to the University destitute of the most rudimentary scientific ideas. If, as is sometimes the case, he wishes to take up science on his arrival there, he has to begin with ideas and facts which he might well have learnt in the nursery; if he prefers a literary course, he remains to the end of his life as ignorant of the alphabet of science as any baby. There is room for considerable difference of opinion as to how far the technicalities of any branch of science should be taught to schoolboys, but it must be admitted that in this age, which is above all things an age of science, an understanding of the fundamental laws of at least physics and chemistry ought to form a part of that vague but cherished ideal "a good general education." But are the public schools altogether to blame? In our system of education the universities call the tune, and the schools may be excused if they only play what is called for. The universities do not call for science. They say in effect, "before you can be of us you must know Latin and Greek, and you must know a certain minimum of arithmetic and of algebra or of geometry, but of any knowledge of science you may be as innocent as a babe. We care nothing for it, and we will confer our highest distinctions on you without asking you for one syllable of it."

The gates to an Oxford career are the University examination, responsions, or more familiarly "smalls," which takes no cognisance of science, and the college matriculation examinations, which in only a few cases give it a bare recognition. So long as this is the case, science will not be seriously taught at the public schools, and there will be a dearth of adequate candidates for science scholarships. The justification of the colleges amounts simply to this—that by their system they have discountenanced the teaching of science in schools, so that the schools cannot send them candidates fit to hold science scholarships, and therefore the scholarships are not awarded.

Oxford fosters the exclusive study of classics in the public schools, and it also does its best to shut its gates against those who have received what is called a modern education in other schools. The burden of matriculation and responsions is not a very heavy one to a fair classic, but it is sufficient to keep out many who have had an exclusively classical education, and is quite prohibitive to most "modern" boys. They go either to Cambridge, where the burden, especially as regards matriculation, is much lighter, or to one of the newer universities. In intention Oxford is possibly right. The product of a modern education is often wofully illiterate. He has the credit of knowing an extensive range of facts, and of having clear ideas about a large number of phenomena; but he is often incapable of stating his facts in plain English, and is so deficient in expression and in the power of arrangement, that clearness is the very last epithet which can be applied to his expositions on paper. His orthography and grammar are too often villainous. This sort Oxford has determined to have nothing to do with, and no true friend of science would wish to shake the determination. It may be doubted, however, whether the particular means of exclusion which are adopted, viz. insistence on a knowledge of Greek accidence, are altogether appropriate. It is quite possible for a man to have plenty of miscellaneous information, a good literary style, and originality of thought, without knowing as much of the Greek irregular verbs as would enable him to pass the ordinary college matriculation examination or responsions. The fact is tacitly admitted; for, with a strange inconsistency, the same section of the University which shudders at the idea of abolishing the Greek test for men, has lately opposed the admission of women to the B.A. degree for this reason, amongst others: that it would involve their having to go through the same Greek course as men, instead of being exempt from it as at present. But if it is asked why Greek is essential to the culture of men and unessential to the culture of women, no answer is vouchsafed.

The amount of Greek required for responsions is only acquired by some—probably by the majority—of boys at the cost of an amount of time utterly disproportionate to the results obtained. For in the end, though they may scrape through examinations, they really know no Greek worth mentioning, and what little knowledge of it they may have acquired is so fugitive that in a year or two after the examination they could not conjugate a Greek verb, and would be lost if they attempted to construe the easiest passages from Xenophon. It is idle to say that this modicum of fugitive knowledge is essential to culture. The Greek test is in a great number of instances a complete failure, and the imposition of it serves only to prevent many boys from attaining to culture by means suited to their natural aptitudes.

It is largely due to Greek that the numbers of the science school at Oxford are kept in check. If the University seriously wished the school well, it would allow elementary science, together with a modern language, to be offered as an alternative to Greek in responsions, and colleges would follow suit in their entrance examinations. Were this done, a large number of boys, freed from the trammels of a study which is repellent to them, would be able to learn enough of science to qualify for a science scholarship, and would in addition be able to acquire a knowledge of English and French or German literature sufficient to entitle them to the designation of scholar in the widest sense of the term.

To turn to the question of fellowships. They may be regarded as possible encouragements to science in two ways—prospective and actual. No doubt the prospect of obtaining one out of a considerable number of fellowships in any given subject will attract clever undergraduates to that subject. The actual holder of a fellowship may be supposed to exercise considerable influence in his college in favour of the subject which he professes. Nearly all the science professorships are attached to fellowships in one college or other, and in addition there are thirteen scientific Fellows receiving emolument in various colleges. Therefore it would appear that, in point of influence in college counsels, Oxford is not so very badly off. But the outside world is apt to over-estimate the influence which a Professor-Fellow or an ordinary Fellow exercises in educational matters, unless indeed he be a man of exceptional force of character. Educational questions rarely come before a full college meeting. The control of studies in each college is vested in the few Fellows who are tutors, whose function it is to exercise a general supervision over the moral and intellectual well-being of undergraduates. This supervision has been formed into a system of which it is not too much to say that it is in the highest degree inimical to science. It is quite unlike the system which exists under the same name at Cambridge, and exercises a much greater pressure on undergraduates.

Every freshman on arrival is assigned to a tutor, whose business it is to set him on a course of study, to see that he goes to the proper lectures, that he is punctual in his attendance at them, and attentive to his reading. A tutor may or may not, as the case may be, undertake also the private instruction of his own pupils. Since there are many avenues to the art's degree, it might be supposed that the tutor would point out to each freshman the various courses of study open to him, would give him the choice of any one of them, and the necessary information as to the proper mode of following up his choice when made. Were this done, there is reason to believe that a much larger proportion would select natural science. But the freshman is not invited to make a selection. Scholars, whether classical, mathematical, or scientific, are sent at once to their respective subjects. A commoner, if of more than average ability, is told that he must read for honours in classical moderations, and afterwards for "greats"; if of average capacity, then law or history is indicated; if of lesser ability, the prescription is pass moderations with two pass classical schools, and probably political economy for the third. Neither honour men nor pass men hear of science unless they make particular inquiries about it; and if they do, they are as often as not told that it will not give them the breadth of education necessary for their future careers. Instances can be cited of freshmen anxious to read science having been ordered to take a classical school instead.

Obviously this state of things would not exist if science were adequately represented on the tutorial staffs of colleges. It is most inadequately represented. Christ Church is the only college which shows to advantage in this respect. By reason of special endowments, it maintains three science lecturers, known as Lee's Readers, and of these the two senior are also tutors. There is a science tutor at Keble. (It is interesting, by the way, to note that the two most distinctively religious foundations in Oxford are those which give the most substantial recognition to science: it has not been discovered that their religious character suffers thereby.) In no other college is there a science tutor. There are lecturers, but the powers of a lecturer are not those of a tutor, either in theory or in practice. In some cases, indeed, the individuality of the lecturer may give him an influence coequal with that of the tutors, as is the case at Balliol and Trinity, and elsewhere, as at Merton, New College, Magdalen, and St. John's some considerable freedom of action is conceded to science lecturers; but in other cases, the duties of the lecturer are limited to the arrangement of the work of such men as the tutors may send to them. Speaking generally, it may be said that the tutors propose and dispose the courses of study; lecturers carry their behests into effect. The initiative is in the hands of the tutors who, with few exceptions, are classical, some few being mathematical, and only three scientific. By excluding scientific men from tutorships the Oxford colleges keep science at arm's length.

Three causes, then, militate against the increase of the scientific school at Oxford: the absence of any test of scientific acquirements in responsions and in most college entrance examinations, the severity of the Greek test, and the exiguous number of science tutors in colleges. These causes might easily be removed, but Oxford does not remove them, and, as a whole, it is unwilling to do so. At the bottom of it there is the wish that it should remain in the present what it has been in the past—the home of classical studies and of metaphysical philosophy. There may be those who would maintain that a university has the right to determine what courses of study should be characteristic of it. But it may be urged that the function of a university is not to be exclusive. Should it not rather be its duty to recognise and bestow its approval on the intellectual movements which have done, and are doing, most for the advancement of mankind? He would be singularly blind to what is going on around him who would deny that natural philosophy has been the great intellectual movement of this century, and that its methods and conclusions have been forced, willy-nilly, on every form of study that exists. But blindness seems to be prevalent among the majority at Oxford, or if not blindness, then wilful obstinacy. For its graduates, in their capacity as members of the University, have been obliged to give public sanction to science, and to spend large sums of money in making provision for teaching it. But in their more private capacities, as Fellows of Colleges, they stultify themselves by stopping the stream at its fountain-head. The endowments of colleges were given for the advancement of religion and sound learning. In times gone by sound learning meant Greek, and why? Because Greek literature contained not only all the metaphysical, but also all the natural philosophy known to the world. It is long since Artistotle has ceased to be the authority in natural, that he still is in metaphysical, science. But in the course of change the authorities have clung to Aristotle, and the endowments which originally were devoted to all sections of his work are now confined to only a part of them. The schoolmen, Duus Scotus amongst them, argued with as much subtlety about the scientific as about the logical teachings of Aristotle, and in so far imitated the spirit as well as the letter of the Greeks. Nowadays the letter remains, but the spirit is lost to the classicists, and has gone over, deprived of its material endowments, to science. How much longer will Oxford cling to the belief that it is the language in which they wrote, rather than the spirit in which they worked, which made the Greek philosophers the fathers of thought? It is indeed a curious satire on a modern classical education that the very things in which the Greeks were most interested are those which the Greek student of to-day most disparages.

It is to be hoped that Oxford will become awake to the unreasonable attitude which it has adopted towards natural science, unreasonable alike from the point of view of modern requirements and of the purposes of the philosophers whom it professes to venerate. For its own sake it is to be hoped that the awakening will come from within; if it does not, it will assuredly come from without. The University has just had a reminder of the dissatisfaction which was felt with the place assigned to science in its local examinations, and it has made haste to repair the defect. The dissatisfaction with its external examinations is as nothing compared with the growing dissatisfaction with its internal system, which, if left unremedied, must prejudice its reputation and destroy the influence which it possesses in the intellectual world.

Let it be said, in conclusion, that there are many at Oxford who are classical to the core, yet would willingly do all that is required for the advancement of natural science. They are mostly to be found among the middle-aged, not among the younger graduates. If certain actions of classical Oxford have been condemned in what precedes, exception is of course made of the more liberal minority, whose actions, if left unfettered, would be all that the most bigoted man of science could desire.

NOTES.

We are informed that notification of the following additional delegates to the International Conference on the Catalogue of Science has now been received at the Royal Society:—Austria: Prof. Ernst Mach, Prof. Edmund Weiss. Germany: Prof. Walther Dyck (Munich), Prof. Van 't Hoff (Berlin), Prof. Möbius (Berlin), Prof. Schwalbe (Berlin), Oberbibliothekar Wilmanns (Berlin). Norway: Dr. Jörgen Brunchorst. The list of delegates is therefore now a remarkably complete and full one.

Sir George Baden-Powell has completed his arrangements for taking an observing party to Novaya Zemlya to observe the forthcoming solar eclipse. He will be accompanied by Dr. Stone, of the Radcliffe Observatory, Oxford, and Mr. Shackleton, of the Solar Physics Observatory, South Kensington.

Among the Civil List pensions shown in a return just laid upon the table of the House of Commons, we notice a pension of £200 to Mrs. Huxley, one of £120 to Mr. James Hammond, and one of £120 to Mr. Oliver Heaviside.

Prof. van de Sande Bakhuyzen, Professor of Astronomy in the University of Leiden, has been elected a Correspondant of the Section d'Astronomie of the Paris Academy of Sciences.

Dr. Samuel Wilks, F.R.S,, President of the Royal College of Physicians, has been appointed one of her Majesty's Physicians Extraordinary, in the place of the late Sir George Johnson.

The death is announced of Prof. A. G. Stoletow, Professor of Physics in the University of Moscow. Prof. Stoletow was the author of several important memoirs on magnetism and electricity, the velocity of sound, the critical state, and other physical subjects.

Sir John Pender, who was for many years prominently associated with the promotion of submarine telegraphy, died on Monday. It was largely due to his enterprise and faith in the practicability of laying a submarine wire between England and America, that the capital required to lay the Atlantic cable of 1866 was subscribed. He also took a leading part in the organisation and development of the Mediterranean, Eastern (India and China), Australian, South African, and Direct African cables. It is stated that the cable mileage of the submarine telegraph companies over which he presided at the time of his death amounts to 73,460 nautical miles.

Nothing is safe from syndicates of speculators. From a question asked in the House of Commons on Tuesday, it appears that an attempt is being made to exclude the public from right of way to the Giants' Causeway. Unfortunately that great natural wonder is not public property, and cannot, therefore, be protected from the syndicate which proposes to interfere with the right of access to it.

The distribution of prizes to the students of the Charing Cross Hospital Medical School will take place next Tuesday,